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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/551,233	04/17/2000	Katsuyoshi Matsuura	FUJ 99228 CIP	9686

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William J Kubida Esq
Hogan & Hartson LLP
Suite 1500
1200 17th Street
Denver, CO 80202

EXAMINER	
LEE, HSIEN MING	
ART UNIT	**PAPER NUMBER**
2823	

DATE MAILED: 04/28/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/551,233	MATSUURA ET AL.	
	Examiner	Art Unit	
	Hsien-Ming Lee	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *24 February 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *12 and 15-19* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *12* is/are allowed.

6)☒ Claim(s) *15-19* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Remarks

1. Applicants' cancellation to claims 1-11, 13-14 and 20-28 is acknowledged. Thus, claims 12 and 15-19 are pending in the application.

Grounds of Rejections

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 15-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Cuchiaro et al. in view of Izuha et al. (US 6,060,735) and Chu et al. (US 6,287,637).

Cuchiaro et al., in Fig.1 and related text, teach the claimed device, comprising:

- a substrate 102;
- an active device element 110 formed on a substrate 102 (Fig.1);
- an insulation film 114 provided over said substrate 102 to cover said active device element 110 (Fig.1);
- a lower electrode layer 116/120 containing Pt provided over said insulation film 114, wherein the lower electrode 116/120 comprises a *Ti layer 116* and a *conductor layer 120 (Pt)*;
- a PZT ferroelectric film 122, having *a perovskite structure*, provided on said lower electrode 120; and

- an upper electrode 124 provided on said PZT ferroelectric film 122 (Fig.1).

Cuchiaro et al. do not teach that said PZT ferroelectric film 122 has a *columnar* microstructure extending from an interface between said lower electrode 120 and said PZT ferroelectric film 122 is in a direction substantially *perpendicular to* a principal surface of said lower electrode 120, said PZT ferroelectric film 122 generally has a *<111> orientation* extending continuously from a bottom surface of said PZT ferroelectric film 122 to a top surface of said PZT ferroelectric film 122 and consisting of *crystal grains* generally having said *<111> orientation* and a substantially *uniform* grain diameter of *less than about 200 nm*.

However, Izuha et al. (Figs. 1-7), in an analogous art, teach the claimed semiconductor device, comprising a semiconductor substrate 1; a lower electrode 4 provided over the semiconductor substrate 1; a ferroelectric PZT film 5 on said lower electrode 4 (Fig.1), said ferroelectric PZT film 5 (col. 4, lines 52-53) having a *columnar* microstructure extending from an interface between said lower electrode 4 and said ferroelectric PZT film 5 (Fig. 4A) in a direction substantially *perpendicular to* a principal surface of said lower electrode 4 (col. 2, line 57 through col.3, line 45), said ferroelectric film 5 is extending continuously from a bottom surface of said PZT ferroelectric film to a top surface of said PZT ferroelectric film and consisting of *crystal grains* having a generally *uniform* grain diameter of *less than about 200 nm* , i.e. ranging from 5 to 500 nm (col. 6, lines 52-53 and Fig.4A).

Therefore, one of ordinary skill in the art, at the time the invention was made, would have been motivated to provide the semiconductor device of Cuchiaro et al. having a columnar microstructure extending from the interface between the lower electrode and the ferroelectric film in a direction substantially perpendicular to the principal surface of said lower electrode, as

taught by Izuha et al., since Cuchiaro et al., and Izuha et al. have similar structure including a laminate film of the lower electrode, the ferroelectric dielectric and the upper electrode disposed in the order; and with the structure of Cuchiaro et al., and Izuha et al. it would provide a lattice-matching structure, which, in turn, would reduce current leakage in the device (abstract, Izuha et al.).

Still, Cuchiaro et al in view of Izuha et al. do not teach that the PZT ferroelectric film generally has a <111> orientation and consists of crystal grains generally has the <111> orientation.

Chu et al., however, teach the claimed ferroelectric PZT film and crystal grains with the <111> orientation in a semiconductor device, which would improve electrical characteristics of the device (col. 3, lines 47-55).

Therefore, one of ordinary skill in the art, at the time the invention was made, would have been motivated to provide the semiconductor device of Cuchiaro et al. in view of Izuha et al. having ferroelectric PZT film with a <111> orientation and consisting crystal grains with the <111> orientation, as taught by Chu et al., since by this manner it would provide a semiconductor device having better electrical properties.

Allowable Subject Matter

4. Claim 12 is allowed.

5. The following is a statement of reasons for the indication of allowable subject matter:

The prior art of record, Cuchiaro et al. (US 6,165,802), teach a method of fabricating a semiconductor device having a ferroelectric capacitor 118, comprising the steps of:

- forming an active device element 110 on a substrate 102 (Fig.1);

- forming an insulation film 114 over said substrate 102 to cover said active device element 110 (Fig.1);
- forming a lower electrode layer 120 of said ferroelectric capacitor 118 over said insulation film 114, said lower electrode layer being formed on a layer 116 containing Ti atoms;
- forming a ferroelectric film of a PZT 122 on said lower electrode 120 as a capacitor insulation film of said ferroelectric capacitor 118 (Fig.1);
- crystallizing said ferroelectric film 122 by applying a thermal annealing process in an atmosphere containing an oxidizing gas (i.e. oxygen) (col. 8, lines 20-30); and
- forming an upper electrode layer 124 on said ferroelectric film 122 (Fig.1), wherein said step of crystallizing said ferroelectric film 122 is conducted by supplying oxygen controlled to cause an oxidation in the Ti atoms that have reached a surface of said lower electrode 120 from said layer part 116 containing Ti atoms due to the elevated temperature in the crystallizing step.

In contrast, Cuchiaro et al. do not teach crystallizing the ferroelectric film under a reduced total pressure in the range between 1 Torr and 40 Torr such that peeling of the ferroelectric film is substantially reduced.

Chu et al. to US 6,287,637 teach crystallizing the PZT ferroelectric film under a reduced oxygen partial pressure atmosphere (col. 6, lines 41-47) in the range of 10^{-4} to 100 Torr (col.7, line 28), wherein the reduced oxygen pressure is a partial not a total pressure, i.e. the ambient for the crystallizing comprises *oxygen and argon, not pure oxygen*. Although Chu et al. do suggest

that crystallizing the ferroelectric film can be performed in a pure oxygen ambient, Chu et al. do not teach the reduced total pressure of oxygen is in the range between 1 Torr and 40 Torr.

Response to Arguments

6. Applicant's arguments filed 2/24/04 have been fully considered but they are not persuasive.

Applicants' argument is on the ground that Izuha et al merely suggest that "**a single columnar crystal grain** has a uniform grain diameter from the bottom part to the top part thereof (see column 5, lines 3-56)." Applicants thus asserted that Izuha et al. do not disclose "the uniformity of the grain diameter between **different** columnar grains as claimed." (page 5) (Emphasis added)

In response to the argument, applicants have misinterpreted the teaching of Izuha et al. that the uniform columnar grain is a single grain. Contrary to the argument, Izuha et al. clearly stated that "[t] columnar **grains** A **are** composed of crystal **grains a, b, and c** that successively grow in the nearly vertical direction to the surface of the substrate." (col. 5, lines 24-26) (Emphasis added) Obviously, uniform columnar **grains** A in Izuha et al. **are plural**.

In addition, claim 15, at lines 12-13, merely claims "consisting of crystal grains generally having said <111> orientation." It does **not claim** that the crystal grains are **different** from each other.

For the above reasons, the rejection to claims 15-19, as set forth in the previous Office Action, is deemed proper.

Conclusion

7. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hsien-Ming Lee
Examiner
Art Unit 2823

April 23, 2004

Hsien Ming Lee 4/23/2004